EXOBIOLOGICAL FEATURES WITHIN ALH84001: CURRENT OBSERVATIONS. Everett K. Gibson, Jr.[1], David S. McKay[1], and Kathie Thomas-Keprta[2]. [1] SN, SS&ESD, NASA Johnson Space Center, Houston TX 77058 and [2]C23, Lockheed Martin Inc., NASA-JSC, Houston TX 77058.

During the past year additional information has become available about the history of ALH84001 meteorite. Detailed geological history of the sample has been presented by Treiman (1) who shows that this meteorite has undergone multiple shock and heating events. We noted previously that ALH84001 is a complicated rock and one must be extremely careful in any interpretation of the presence of possible biogenic signatures (2,3). Treiman (1) shows evidence for four or five deformation and shock metamorphism events in the history of ALH84001 along with depositional from events which formed the carbonate globules. The model presented by Treiman (1) can account for both possible biogenic and inorganic signatures described by several groups (4-9).

Our original hypothesis (2) for the evidence of possible past biogenic activity included: (a) iron oxides having sizes, shapes and textures similar to terrestrial biominerals, (b) carbonate globules formed at temperatures capable of supporting biogenic activity, (c) indigenous organic compounds (PAHs) associated with regions containing carbonate globules, and (d) morphologies of segmented, spherical and elongated features similar to terrestrial microfossils and nanobacteria. As noted in our original paper (2) none of these observations is in itself conclusive: collectively, particularly in view of their close spatial association, they were taken as implying primitive life on early Mars. Additional supporting evidence comes from: (i) carbon isotopic compositions (-55 to -65 per mil) (10), (ii) biofilm-like textures (11), (iii) chains of magnetite grains within carbonate globules similar to those produced by magnetotactic bacteria (12), and (iv) oxygen isotopic compositions within individual globules which rule against a high temperature origin (6,8) and are indicative of low-temperature processes (13).

Recently Bada et al. (14) and Jull et al. (15) suggested that ALH84001 contains carbon-bearing components which are suggestive of terrestrial contamination. We are not surprised by the identification of contamination from the Antarctic environment identified by (14,15). In fact, all Antarctic meteorites show some contamination including the alteration of selected minerals and the growth of secondary alteration products (16). We (2) did not propose that ALH84001 contained martian amino acids, only martian PAHs. We pointed out that the PAHs were closely associated with the carbonate globules. It is not clear where the amino acids analyzed by (14) are located. In fact, the "chunk" of ALH84001 analyzed by (14) may have contained secondary weathering products which might have contained amino acids from the Antarctic melt waters. Clemett et al. (17) have recently argued that the Becker et al. (18) model for PAHs introduction into Antarctic meteorites is seriously flawed and PAHs contamination of the samples by the Antarctic environment and ice is negligible. The spectra of PAHs found by (17) in ALH84001 do not match the spectra of PAHs in Antarctic and Greenland ice or other Antarctic meteorites. Amino acid contamination is highly probable for meteorites collected in the Antarctic environment.

Most if not all Antarcitc meteorites contain weathering products, including secondary carbonates, such as hydromagnesite (16) and such phases would be formed from modern day ^{14}C. ^{14}C is found in every Antarctic meteorite analyzed for it. It is impossible to distinguish between ^{14}C in organic material and ^{14}C in secondary Antarctic produced carbonates-especially if stepped temperature extraction is utilized to separated the components bearing the ^{14}C. Previous work from Jull's laboratory show that ^{14}C from the Earth's atmosphere may also exchange with indigenous carbonates in Antarctic meteorites (19). The ^{14}C story from Antarctic meteorite continues to be problematic. It is our determination that the data presented by (14,15) simply do not distinguish between secondary components and indigenous reduced carbon-bearing phases within ALH84001. We argue that the detection of Antarctic contamination in ALH84001 does not detract from our arguments (2,17) that PAHs are indigenous and hence from Mars.

We previously reported the presence of possible biofilms in ALH84001 (11). In terrestrial settings, bacteria and other microorganisms synthesize extracellular polymeric layers or structures classified as biofilms, which are a complex mixture of organic polymers composed primarily of extracellular polysaccharides (EPS). These structures are typically formed external to cells. Biofilms provide a confined volume that can be regulated by cellular activity to be more suitable for cell metabolism and growth. They may also help conserve moisture in desiccation environments (20) or provide a structure to anchor cells and protect them from external forces and movements (21,22). Biofilms may become mineralize and reside in the geologic record as fossilized materials (23).

Only within the past several years have biofilms been recognized to play an important role in the terrestrial carbon cycles within both marine and fresh water environments (24). If life existed in the early history of Mars, when oceans or closed basins of water were present, biofilms may have been produced and mineralized to form remnant structures. Biofilms have been identified in selected SNC meteorites.

Dissolved organic carbon is present everywhere in oceans and enclosed water bodies on Earth. Analysis has shown a portion to be a polysaccharide produced by marine algae and composed of several sugars. These carbon-rich materials remain associated with silicate materials upon burial and after dessication. Allen and McKay (25) have pointed out several biomarkers which can be utilized to identify past biogenic activity. It is possible that some of the biofilm features observed within the SNC meteorites are the remains of the carbon constituents in the martian oceans and water reservoirs present during the early history of the planet.

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